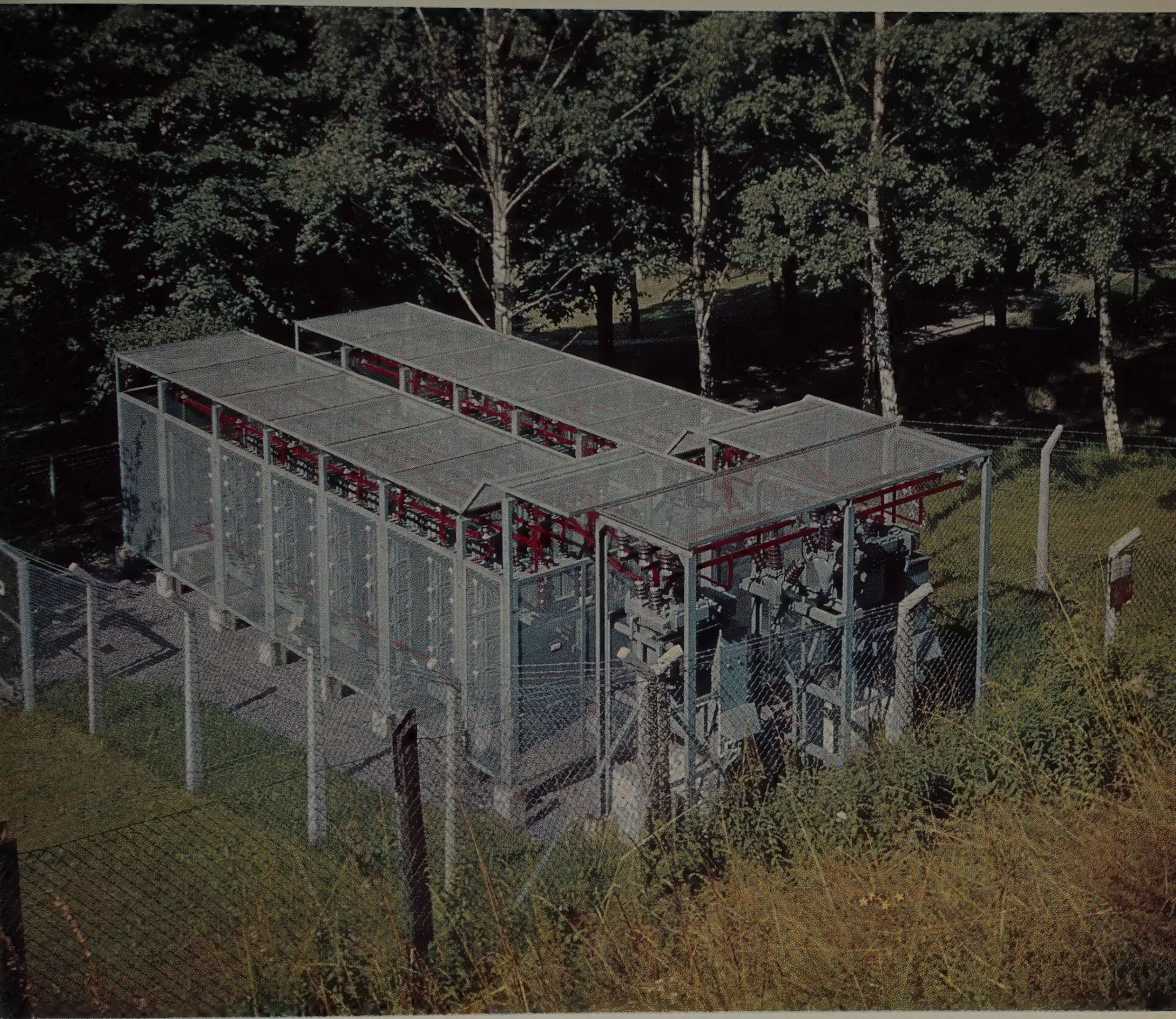

Three-phase shunt capacitor bank, 2 × 3,240 kVAr, 10 kV, 50 c/s, supplied to Yngeredsfors Kraft AB, Mölndal, Sweden. (F 255)

ASEA JOURNAL

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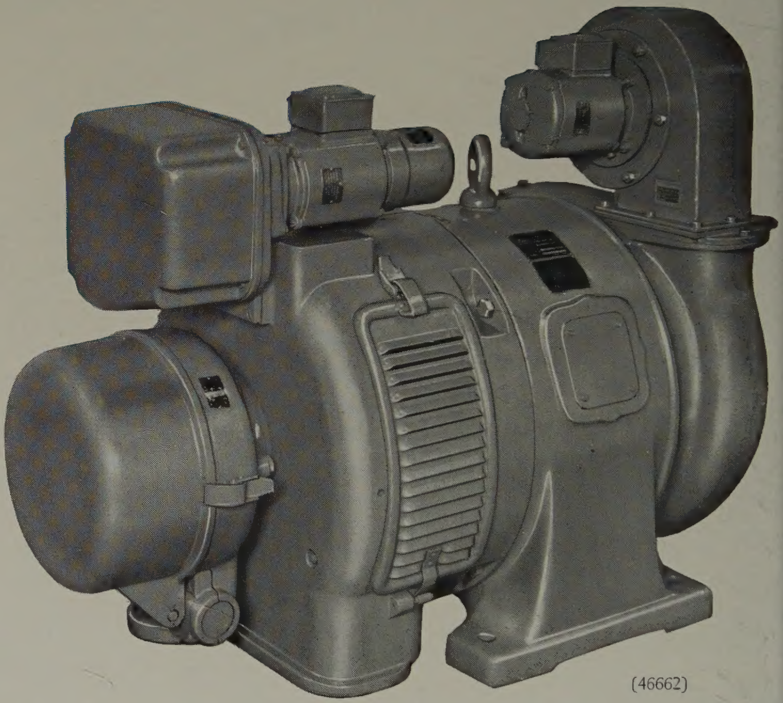
5

Steadily Increasing Production

A higher rate of production can be achieved in the great majority of cases in continuous production processes by increasing the speed of the driving machinery week after week, month after month, as the speed-limiting obstacles, whether mechanical or human, are overcome.

The ideal driving motor for all such process machines is the ASEA commutator motor with continuous speed regulation.



(46662)

Use the ASEA commutator motor with continuous speed regulation for continuous processes

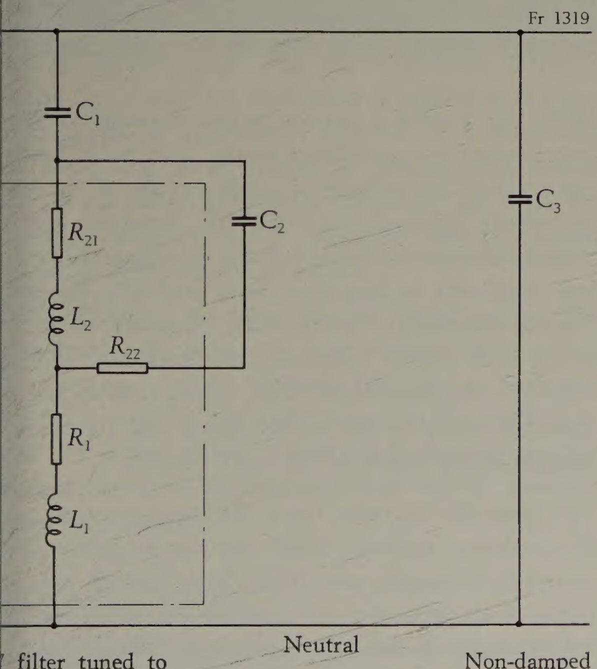
ASEA

APACITOR BANK WITH HARMONIC FILTERS

ans Stackegård, Static Converter Design Departments, Ludvika

U.D.C. 621.319.4:621.316.94
Asea Reg. 4834

*eversing rolling mills fed by rectifiers require a com-
rratively large amount of reactive power. It is there-
re often desirable that capacitor banks for the power-
ctor correction of the network be installed in the im-
ediate vicinity of the rectifiers. The capacitors must
en be combined with a damping filter element as a
otection against harmonic resonance. A filter-type
pacitor bank of 8 MVAr of new design has been set
in the new strip mill at the Surahammar Steelworks
AB Skandinaviska Elverk. The article deals with the
ect of the harmonics, the design of the filter and the
quisite acceptance tests.*



filter tuned to
es resonance for
5th and 7th
monics

Non-damped
capacitor

Capacitor for 3 MVAr
Filter capacitor
Main capacitor for
5 MVAr
Filter reactor

L_2 Filter reactor
R_1 Loss resistance for L_1
R_{21} Filter resistor
R_{22} Filter resistor

. 1. *Single-phase diagram of the capacitor bank in*
ahammar.

CONSUMPTION OF REACTIVE POWER IN REVERSING ROLLING MILLS

The amount of d.c. power produced by a controlled static converter is dependent on the control angle, i.e., on the direct voltage required and consequently on the speed of the motor. The apparent power supplied by the converter to the a.c. network, when the current is constant, is more or less independent of the control angle. If the counter voltage on the d.c. side varies, therefore, so does the phase angle on the a.c. side. A reversing rolling mill, where large variations in load are frequent, consequently consumes relatively large amounts of reactive power. This is, naturally, particularly true of large plants such as the reversing strip mill at the Surahammar Steelworks, where the converters have an installed mean output of approximately 9 MVA.

POWER-FACTOR CORRECTION

On account of the present lack of reactive power in Central Sweden, the private power distributors have been forced to supply the reactive power they need largely on their own. The cheapest method of power-factor correction of this type is generally to use capacitors. These should naturally be placed close to the main consumers of reactive power, on account of transmission losses. When AB Skandinaviska Elverk in 1959 were planning the installation of shunt capacitors in Central Sweden, therefore, it was considered expedient to place a relatively large unit close to the reversing mill at the Surahammar Steelworks. It was thought that the capacitor bank should preferably be installed directly in parallel with the rectifier transformers, which are fed with 6.3 kV. Transmission losses would thereupon be reduced, but, on the other hand, special precautions would have to be taken with regard to the static converter harmonics.

STATIC CONVERTER HARMONICS

On account of the smoothing of the direct current, the phase current on the a.c. side of a static converter al-

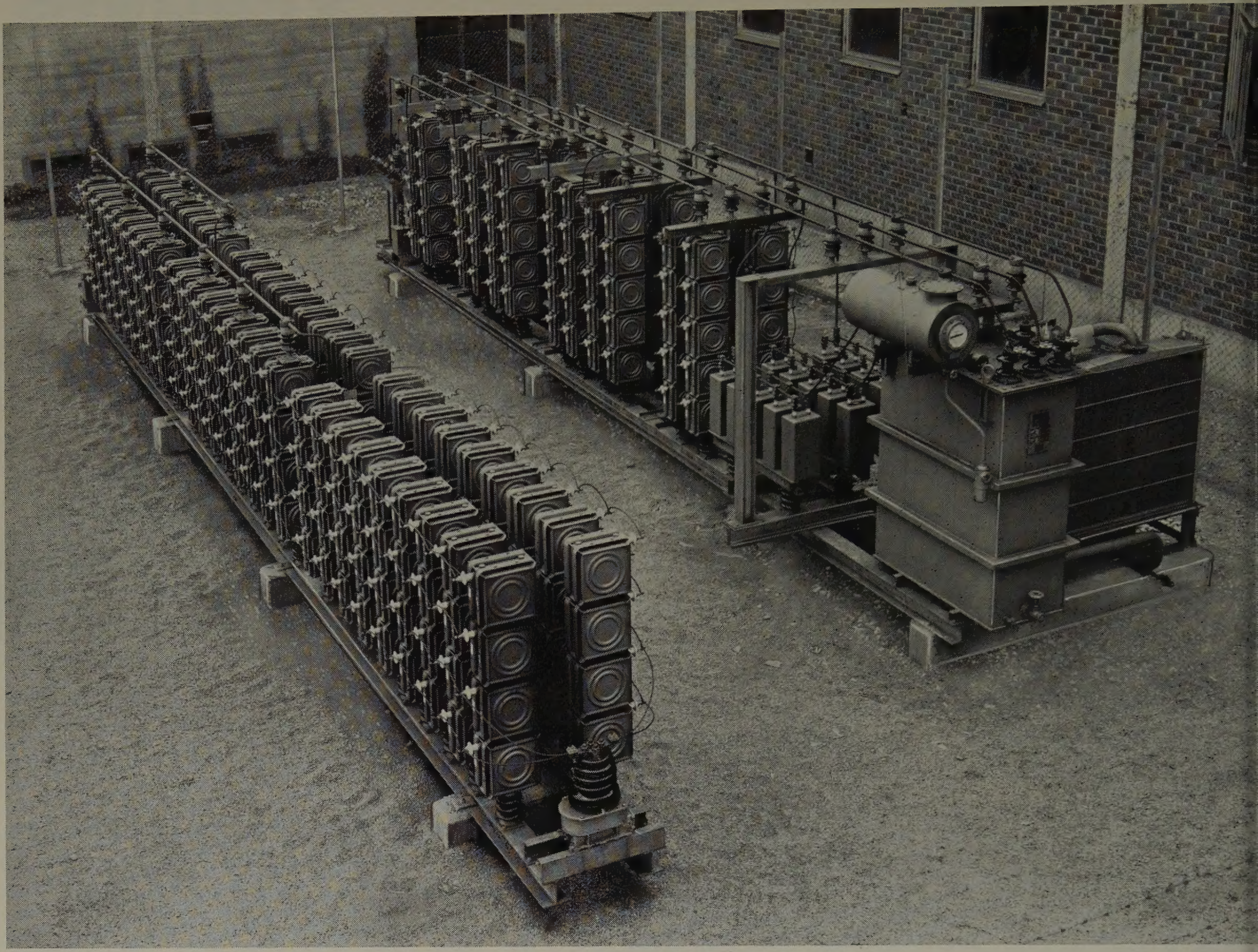


Fig. 2. The capacitor bank in Surahammar. On the left can be seen the 5-MVAr section and on the right the 3-MVAr section with filters. (55700)

ways has a step-like wave shape, which can be conceived of as a phase current rich in harmonics. It can be shown that the amplitude of the harmonics will not exceed a figure inversely proportional to the ordinal number of the harmonics $(I_n = I_1/n)$.

Static converters for rolling mills are normally designed for six-phase service. The fifth, seventh, eleventh and thirteenth harmonics are then the dominant ones (twelve-phase service gives the eleventh and thirteenth as the lowest harmonics). The fifth harmonic current, according to the above, is approximately twenty per cent of the fundamental harmonic current of the static converter. In practice, the amplitude will be lower, especially for harmonics of a higher order.

INFLUENCE OF HARMONICS

Harmonics may have several deleterious effects, for example:

1. Heating
2. Over-voltages
3. Radio interference
4. Torque disturbances

With the powerful supply networks now availab transformers are not subject to any appreciable heatir nor do any over-voltages occur as a result of the sta converter's harmonics as such (cf., however, the sonance phenomena below). Radio interference becon less significant as long wire lines gradually disappe Torque disturbances are possible, especially on accou of the fifth current harmonic, which, in a.c. machin induces a counter-rotatory flux, which reduces the n chanical torque output of the motor and gives rise supplementary losses in the rotor winding.

The harmonic currents from the static converters in themselves normally much too low to cause distu bances in networks, even if the latter include capaci banks. Both networks and transformers, of course, ha a good damping effect on harmonics.

In certain circumstances, however, resonance phe mena may occur, and these require close attention. series resonance circuit may, for example, arise fr a capacitor used for power-factor correction and transformer supplying it. The impedance for a gi harmonic may then be low enough to prevent a go deal of the harmonic current from the rectifier fr taking this path, which might result in overloading the capacitor and transformer. For such a resonance present any danger, a very exact tuning between the pacitor and the transformer is required, and the medy is usually quite simple: an adjustment of the pacitance value.

ith regard to harmonics the static converter can be nsidered as a constant current generator. In the case series resonance, therefore, the resonance current will t exceed the harmonic current generated. With paral- resonance, on the other hand, amplification may cur, resulting in the resonance current exceeding the rmonic current generated. This presupposes that the sonance circuit has a low damping factor, which is pecially the case with large capacitor banks. The risk high resonance currents occurring is particularly great ıen the capacitor bank is placed between a converter d its supply transformer. A capacitor bank such as at in Surahammar could be subject to injurious overltages on account of the harmonics, as a result of rallel resonance with the inductance of the supply twork, if there is no filter protection. Furthermore, ere might be undue heating of the transformer and the k of local radio interference occurring would increase.

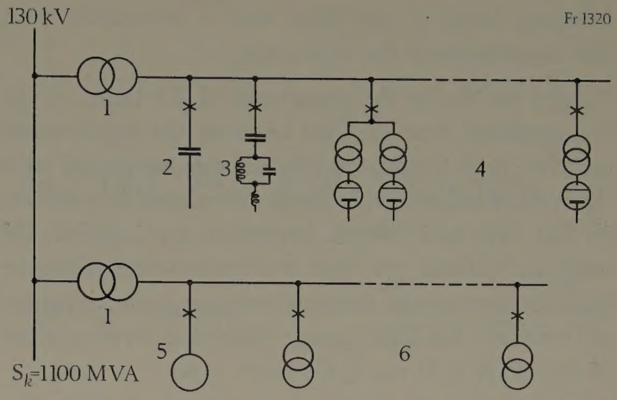
CCEPTABLE HARMONIC CONTENT

is generally believed that a capacitor bank protected filters installed near the converters should rid the twork of harmonics. The line impedance, however, normally so low that the harmonic current in the netrk cannot be appreciably reduced at a reasonable st, even with series resonance circuits connected in rallel. As stated previously, this is in any case not rmally necessary, since harmonic currents within asonable limits can be tolerated.

hen designing the filter for the capacitor bank in rahammar, therefore, the only requirement was that e switching in of the capacitor bank should not cause plification of the harmonic current in the supply netrk. In other words, inadequately-damped parallel sonance between the capacitor bank and the network ould be prevented.

HOICE OF FILTER

is not possible to eliminate the risk of resonance been the capacitor bank and the network by placing e point of resonance at a safe frequency between the rmonic frequencies. Converters produce a spectrum harmonics, and the frequency interval between them so small that resonance may occur when there are iations in the line inductance and frequency, even if orts are made to place the point of resonance halfy between two harmonic frequencies. On the other nd, it is common practice to connect a reactor in ies for series resonance below the frequency of the lowest harmonic. However, this results in a high reactor power and poor harmonic filtering.



1 Transformer for 20 MVA, 130/6 kV, $u_k = 10.7\ \%$
2 Capacitor for 5 MVAr
3 Capacitor for 3 MVAr and 5–7 filter
4 Static converter 1–7 for a total of 9 MVA
5 Rotary converter for cold rolling mill for 3.8 MVA
6 Furnaces and auxiliary power for a total of approx. 4 MVA

Fig. 3. Circuit diagram for the strip mill in Surahammar.

The Surahammar capacitor bank has been so designed that the main capacitor gives parallel resonance with the line inductance near the seventh harmonic. Parallel with this, however, a series resonance filter for the fifth and seventh harmonics has been installed (cf. Fig. 1). Thus the risk of parallel resonance has been effectively eliminated. This method can only be used where the line inductance is practically constant, ensuring that the parallel resonance frequency is relatively stable. In this case the main part of the line inductance is located in the line transformer, which means that the inductance variation is small.

The advantage of this arrangement was that it was possible to install a large part (5 MVAr) of the capacitor power (8 MVAr) without the protection of a series reactor or damping resistors.

Four per cent of the reactor power and a similar percentage of increased capacitor power (referred to the capacitive power of the battery for the fundamental harmonic frequency) are required for tuning to the fifth harmonic with a series reactor. The corresponding figure for tuning to the eleventh harmonic is one per cent.

The connection of reactors and other tuning circuits in series with the capacitors naturally increases losses. The fundamental harmonic losses are dependent only on the reactors' loss resistances and damping resistors, if the latter are installed. The harmonic currents are, of course, dependent on the converter load, which means that the harmonic losses of the filter vary in accordance with the exploitation of the converters.

To give an idea of the importance of the losses, it can be mentioned that the total losses in the Surahammar capacitor bank increase by fifty per cent, compared with the normal losses of the capacitors, when filter circuits for the fifth and seventh harmonics are installed. Of these thirty-three per cent are fundamental harmonic losses in reactors and damping resistors, while seventeen per cent are harmonic losses, where the rectifier plant of 4.5 MVA is in use 5,000 hours a year.

The total harmonic losses in the a.c. network are practically unchanged, but the losses now confined to the filter circuits previously occurred in the supply network. It should, however, be noted that normal wattmeters are not sensitive to harmonics in the current alone, so that this change is insignificant, both with regard to the power supplier and the consumer.

COMPONENTS

The filter design is shown in Fig. 1, while Fig. 2 consists of a photograph of the capacitor bank. The configuration of the network is shown in Fig. 3.

In the capacitor bank the main section C_3 (5 MVAr) contains 216 units of type CTD 2, while the capacitor C_1 in the 3-MVAr section has 120 units of the same type. The filter capacitor C_2 consists of 15 units of type CLB 5.

The reactors are of the shell-type, three-phase variety. They are all housed in one tank, in which the damping resistors are also placed. The capacitors are supplied with differential protection. This is particularly important in a capacitor bank equipped with filters, since no substantial alteration can then be made in the capacitance value without jeopardising the tuning.

TUNING

It is important that the "5–7 filter" (C_1–C_2) be placed very close to the harmonic frequencies; otherwise the damping of the fifth and seventh harmonics would l reduced, and consequently there would be a risk parallel resonance between the 5 MVAr section ar the line inductance.

The damping has to be quite low in order to redu filter losses. Adjustment of the tuning is made possib through dividing up the capacitive components in tl usual way into a number of relatively small standa units. The reactors are designed without taps for adjus ment, since tuning is effected by trimming the capacitor

As the tolerance requirements were easily met durir the manufacture of the reactors, only a slight adjus ment of the capacitors was required. Acceptance tes showed that the tuning was not so critical as had bee feared. The fine trimming of the filter tuning had a insignificant effect on the harmonic filtering.

HARMONIC FILTERING

As stated above, the filter circuits were designed wi an eye to preventing the harmonics, which the cor verters generate on the line side (130 kV), from i creasing when the capacitor bank is connected in. It w established by means of wave analysis during the a ceptance tests that this requirement had been fulfille The harmonic content on the line side dropped to le than half for all harmonics when the capacitor bar was switched in.

CONCLUSION

Static shunt capacitors can be used with advantage f the power-factor correction of reversing rolling mills fe from static converters. The capacitor bank then has be protected against harmonic resonance. This will n involve too much extra cost either with regard to loss or capital costs.

The supplementary resistors in the circuit and the lo resistances ensure that the tuning of the filter is n critical.

HEATING INSTALLATION WITH 750 kW TRANS- UCTORS

ils Erik Ström, Industrial Plant Division, Special Equipment Department, Västerås

U.D.C. 621.384.3-533.65.077
Asea Reg. 4795, 669

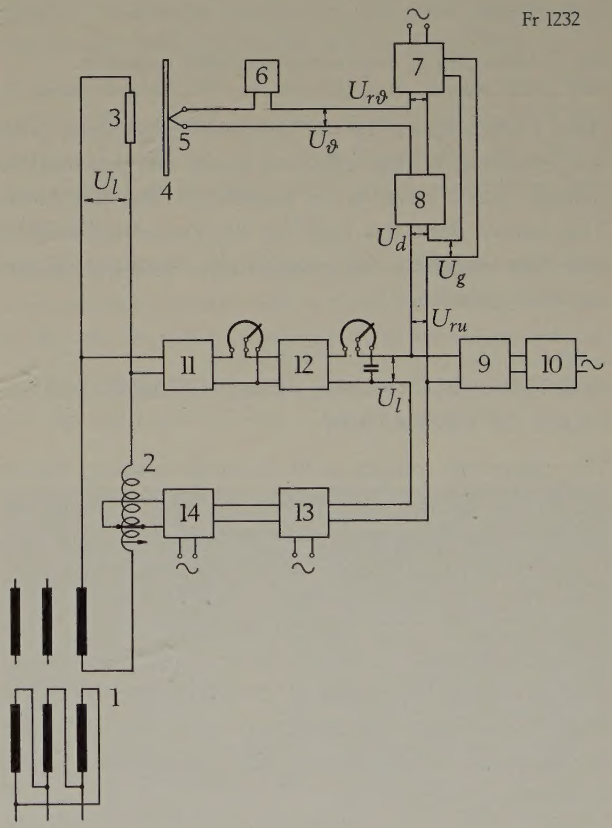
he article describes an electric installation for the heat- g of test pieces in which the main power is regulated / means of large transducers. The heating process is ogramme-controlled within the temperature range -400°C. The equipment can provide, in all, 750 kW r 30 seconds or 250 kW continuously.

/hen heating objects electrically by means of resistor ements in, for example, soaking pits, annealing fur- ıces, heat lamps and so on, the temperature is regu- ted by changing the voltage which is supplied to the esistor elements. This voltage regulation can be ar- nged in various ways, but if considerable demands are ade on the regulation in question as far as rapidity, curacy and temperature range are concerned, it is ap- opriate, for a number of reasons, to make use of trans- ıctors. It is then possible to regulate the voltage con- nuously, and it can be controlled with an accuracy id rapidity which satisfy the highest demands made ı temperature regulation of this kind. The introduction programme control is a simple matter. The output ltage from the transductor is an alternating voltage hich has been distorted because of the transductor ntrol, but it can be used directly for resistance heat- g without rectification or filtration. The efficiency is erefore very high.

ansductors can be manufactured in all the sizes that e feasible for this purpose, and, as far as their con- uction and reliability are concerned, they can be com- red to transformers. As distinct from rotary con- rters, they require little room and maintenance and e easy to install. As is the case with transformers, ey can easily be designed for outdoor erection.

sea have recently supplied the Aeronautical Research stitute of Sweden in Stockholm with a transductor uipment for an installation used for the rapid heating test pieces, and this equipment is described below. ie test pieces consist of parts of aircraft and missiles, d the object of the tests is to ascertain their strength d other properties when they are exposed to rapid ating, for example such as occurs when a body is ac- lerated up to high speed in the atmosphere and when reaches what is popularly called the heat barrier.

The objects are heated by means of infra-red lamps which are directly connected to a transductor-controlled voltage. The temperature of the test pieces follows programme-controlled sequences within the temperature range 0–400°C, and the regulating system permits the lamp voltage to be steered out in 0.1 seconds. In order to achieve rapid heating, the voltage is forced up to about twice the rated lamp voltage. By this means, a temperature derivate of 1,000°C/s is obtained.



1 Three-phase transformer
2 Main transductor
3 Load (infra-red lamps)
4 Test piece
5 Thermo-couple
6 Cold junction
7 Programme device
8 Direct-voltage amplifier (error amplifier)
9 Voltage-limiting device
10 Constant-voltage device
11 Rectifier
12 Filter
13 Transistor amplifier
14 Transductor amplifier

Fig. 1. Elementary diagram showing one phase of the electrical equipment for a 750 kW heating installation.

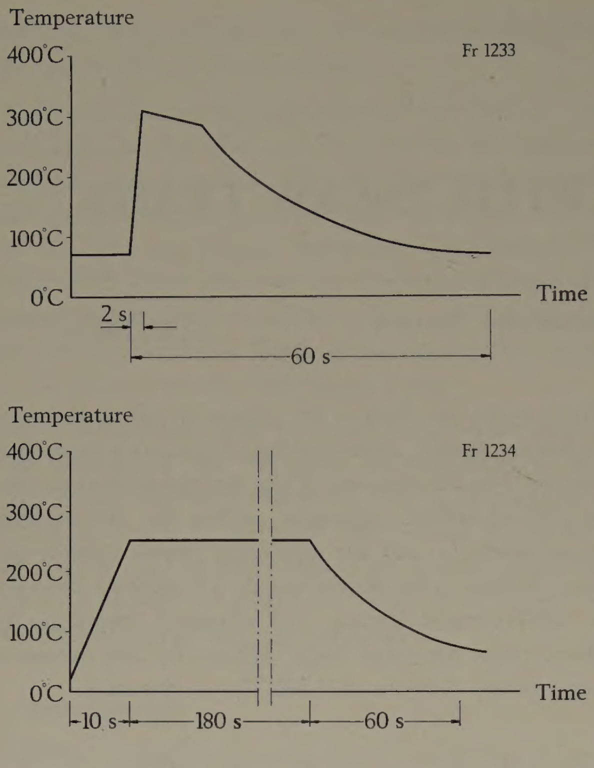


Fig. 2. Examples of programme-controlled sequences.

Asea have supplied all the equipment described, with the exception of the infra-red lamps and appropriate fittings, which have to be adapted to the test piece. The control desk was built by the Research Institute, but Asea supplied the components contained in the regulating system.

THE PRINCIPLE OF THE ARRANGEMENT AND MODE OF OPERATION

The equipment consists of three similar systems, known as T1, T2 and T3, each with a transductor connected to one phase of a three-phase transformer. Together, they can provide 750 kW for 30 seconds, or 250 kW continuously, at 220 V.

The principle of the arrangement can be seen from Fig. 1 and the mode of operation of the equipment is explained in conjunction with this figure. The system is shown in one phase only since the three phases have similar regulating systems.

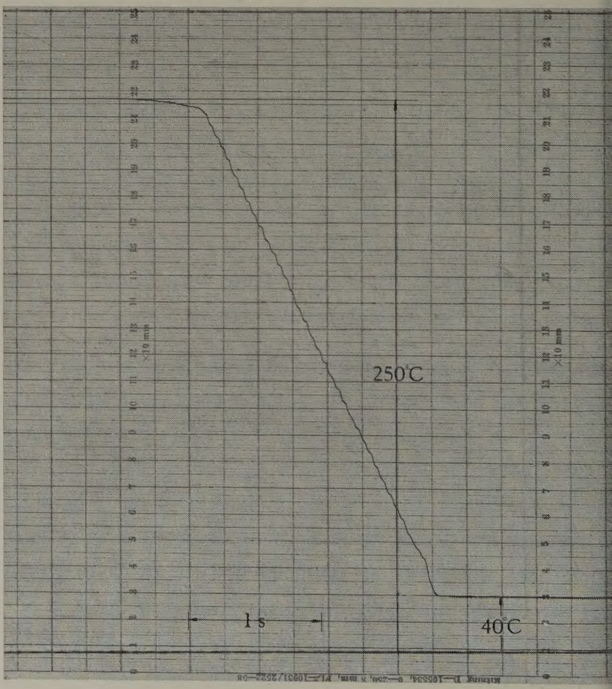
The three-phase transformer 1 feeds, via the main transductor 2, the load 3, which consists of infra-red lamps. These heat a test piece 4, the temperature of which is sensed by means of the thermo-couple 5 which has its cold junction at 6. The reference voltage $U_{r\vartheta}$ is obtained from the programme device 7 and corresponds to the reference value of the thermo-couple voltage. The thermo-couple voltage U_{ϑ} is compared with the reference voltage $U_{r\vartheta}$, and, in this way, a voltage difference $U_{r\vartheta} - U_{\vartheta}$ is obtained which is proportional to the ten perature deviation.

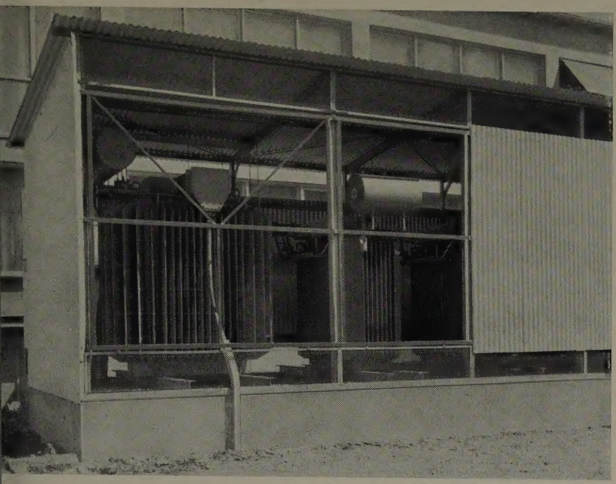
This voltage difference, which can be either positive c negative, is amplified in a direct-voltage amplifier 8, th output voltage U_d of which is added to a voltage U to provide what is designated here as the "bias setting (see below). The summated voltage U_d+U_g, limite with the aid of a voltage-limiting device 9, provides reference voltage U_{ru} for the supply voltage U_l of th infra-red lamps. The voltage-limiting device limits th voltage U_{ru} in the downward direction to zero and, i the upward direction, to a maximum value which corre sponds to the maximum permitted voltage for the lamp

The voltage U_l of the lamps is rectified (11) and filtere (12), and the voltage U_l' so obtained is compared wit the reference voltage U_{ru}. The differential voltage is fe into a transistor amplifier 13, in which an impedanc transformation takes place for adaptation to the inpu side of the following transductor amplifier 14. This, i its turn, controls the main transductor 2, whereupo the regulating circuit is closed.

If the temperature deviates from the value according t the programme, the regulating system is controlled i such a way that the voltage across the lamps is change in such a direction that the correct temperature is ob tained. It should be noted here that the temperatur can be raised rapidly by increasing the infra-red heatin power, while the reduction of temperature depends o the rate of natural cooling of the test piece.

Fig. 3. Record of a programme-controlled sequence in whic the temperature rose linearly from 40°C to 250°C during period of 1.5 seconds. (Z 11665)





ig. 4. *The transformers and main transductors are set up n a concrete platform with a superstructure of aluminium heet. (53340)*

xternal disturbances such as variations in the mains oltage, are eliminated by voltage-feedback in the voltge-regulation system. This system is much more rapid han the temperature regulation itself, and therefore disturbance of this kind does not influence the temerature.

voltage U_g, known here as the "bias setting", is, as as been previously mentioned, added to the voltage $_d$ of the error amplifier. The "bias setting" provides a maller response time and more accurate temperature egulation.

he "bias setting" is obtained from a separate voltage ource in the programme device 7. If the reference voltge is programmed, the "bias setting" should be prorammed too, and it should, as far as possible, be proortional to the derivate of the programme voltage. enerally, programmes are used in which the temerature rises linearly with time, and the "bias setting" an then be a constant voltage which is connected up nd disconnected by the programme device.

ypes of programme in use are shown in Fig. 2. Fig. 3 ows a recorded sequence in which the temperature se linearly from 40°C to 250°C over a period of 1.5 conds.

ONSTRUCTIONAL DESIGN

eneral arrangement

he equipment is fed from a 6 kV high-voltage cubicle f conventional design.

he transformer and the main transductors are set up n a reinforced concrete platform outside the laboratory which the rest of the equipment is placed. Above the ncrete platform, there is a superstructure of aluminim sheet, see Fig. 4.

Plastic-insulated cables run from the transformers and transductors to the distribution and control cabinets which are set up alongside a wall in the laboratory.

Both the power, and control-voltage, cables run from the distribution and control cabinets out to terminal boxes centrally placed on a column in the centre of the laboratory thus enabling the test pieces and the control desk to be located anywhere in the laboratory.

The power is fed from these terminal boxes to the test pieces via movable distribution boxes from which the power is distributed to the infra-red lamps (Fig. 5).

The equipment is operated from control desks, one for each system (Fig. 6).

The main transformer

This is a self-cooled, oil-insulated transformer of conventional design.

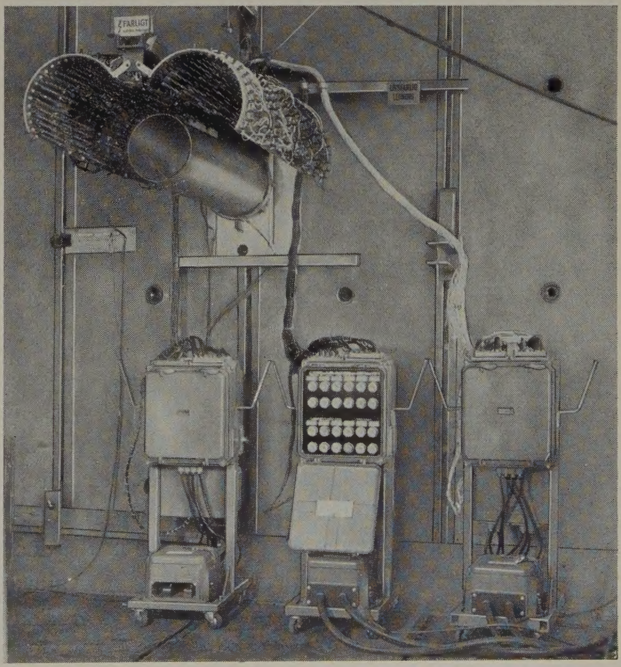
The main transductors

Transductors of this type are to be described in greater detail in a coming number of the Asea Journal, and only a very brief description will be given here.

A main transductor is mounted in an ordinary air-cooled, oil-insulated transformer tank for each of the systems T1, T2 and T3. Each transductor consists of two cores with windings and a selenium valve for self-saturation.

The transductor cores consist of a number of strip-ring cores of grain-oriented silicon sheet steel stacked up one on top of the other. There are three windings, one a.c.

Fig. 5. Power is fed from the movable distribution boxes to the infra-red lamps. (53349)



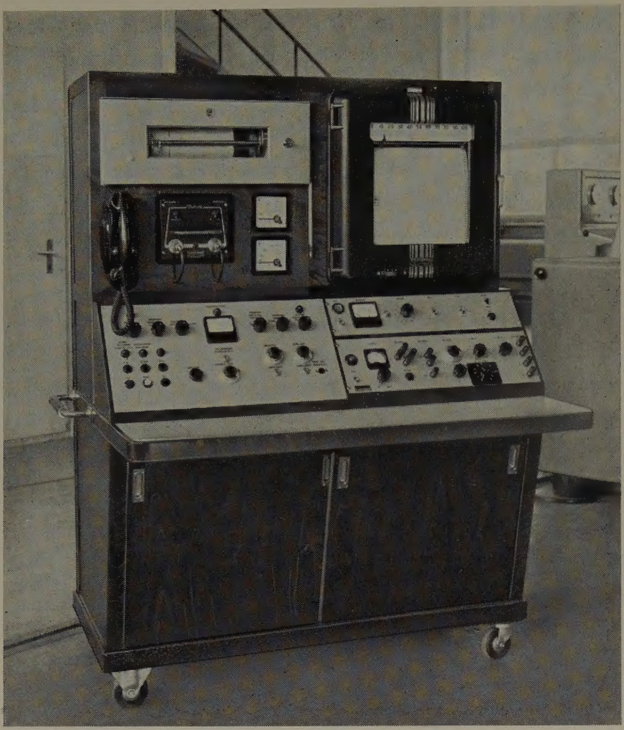


Fig. 6. The equipment is operated from control desks, one for each system. (53352)

winding for the main output, one control winding and one bias winding.

For reasons of cooling, the self-saturation valve is placed at the bottom of the tank.

Each transductor has a bias current device which provides a filtered direct voltage, and a no-load reactor, both located in the distribution cubicle. The reactors make possible the control of the transductors when they are not loaded with the lamps, and they also prevent transient over-voltages arising across the self-excitation valves of the transductors.

Distribution switchgear

The switchgear (Fig. 7) consists of three cubicles, one for each system, each of which contains an isolator, circuit-breaker, various instrument transformers, a device for bias current, and no-load reactors.

The control cubicle

The control cubicle contains most of the components included in the regulating circuit after the error amplifier (8 in Fig. 1). Further, the cubicle contains relay stations for the automatic and the protective functions, as well as a signal station common to all three systems. Some of the operating devices are mounted on the door of the cubicle, namely pushbuttons for the high-voltage circuit-breaker and the change-over switch for various service combinations (see under "Operation").

The control desks

The control desks (Fig. 6) were built by the Researc Institute, but Asea supplied some of the componen and planned those parts included in the regulatin systems.

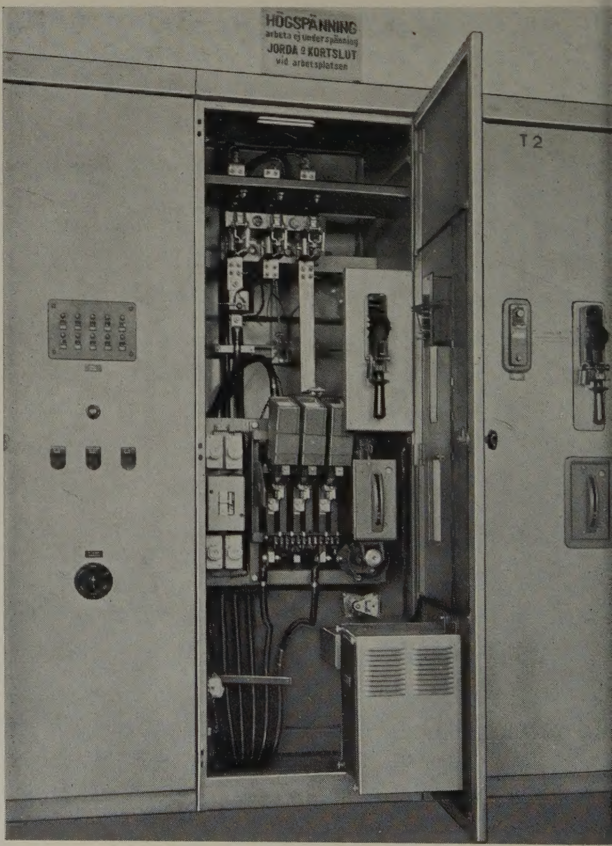
In the main, the control desks contain all the operatin devices except those few which are on the contr cubicle, and they also contain some components of th regulating system, that is, the cold junction 6, the pr gramme device 7 and the error amplifier 8. Furthe there is a temperature-recording instrument which provided with a contact for tripping the circuit-breake in the distribution switchgear when the temperatur exceeds a certain value.

The control equipment

Most of the control equipment is of standard design an is not particularly noteworthy, but certain items ar worth mentioning in the present context.

The programme device 7 consists of a drum driven by synchronous motor and it has a programme curve metallic wire fixed to its cylindrical surface. This wir constitutes a current collector for a linear resistor whic is fed from a 40 V battery. When the drum rotates,

Fig. 7. The low-voltage cubicle contains an isolator, a circui breaker, instrument-transformers, an excitation device and no-load reactor. (53345)



provides the previously mentioned programme voltage $U_{r\vartheta}$.

The error amplifier 8 is a polarised direct-voltage amplifier with a transductor input stage, which provides ±10 V in 700 ohms at an input voltage of ±0.1 mV n 1,000 ohms.

The transistor amplifier 13 is polarised and is built as an emitter follower for impedance transformation with the voltage amplification 1:1 at the input and output voltages of ±2 V. The input impedance is 10,000 ohms and the load impedance 600 ohms.

The transductor amplifier 14 is of Asea standard type YTMA 12, that is to say, it is a two-stage transductor amplifier with negative feedback and an output of 20 W at 1.5 A and 80 V.

OPERATION

Service combinations

The equipment is designed for all possible service combinations of the three systems, so ensuring considerable lexibility in use. Thus, all the three systems can be run ndividually, each from its own control desk. This makes t possible to run three tests simultaneously with different programmes. They can also be run from one and the same desk, that is to say, with the same programme. This makes it possible to obtain a maximum power of 50 kW in one test. It is also possible to run any two ystems with the same programme and the third in accordance with a different programme.

Reconnection between the various service combinations s carried out by means of a change-over switch on the control cubicle.

Automatic control

The operation of the equipment has been made automatic to such an extent that it is convenient to handle nd no faults can arise because a control operation is forgotten or because the sequence of control operations s incorrect.

The control voltage is connected up automatically when the change-over switch for the various service combinations is turned from its off position. Thereupon, a imer starts up, the object of which is to prevent the quipment from being used before the electronic equipment has been warmed up. The low-voltage circuit-breaker cannot be closed unless the following four conditions are fulfilled:

. The programme device must be in its starting position
. The timer must have closed
. The high-voltage supply must be switched on
. The main transductors must be set at minimum output

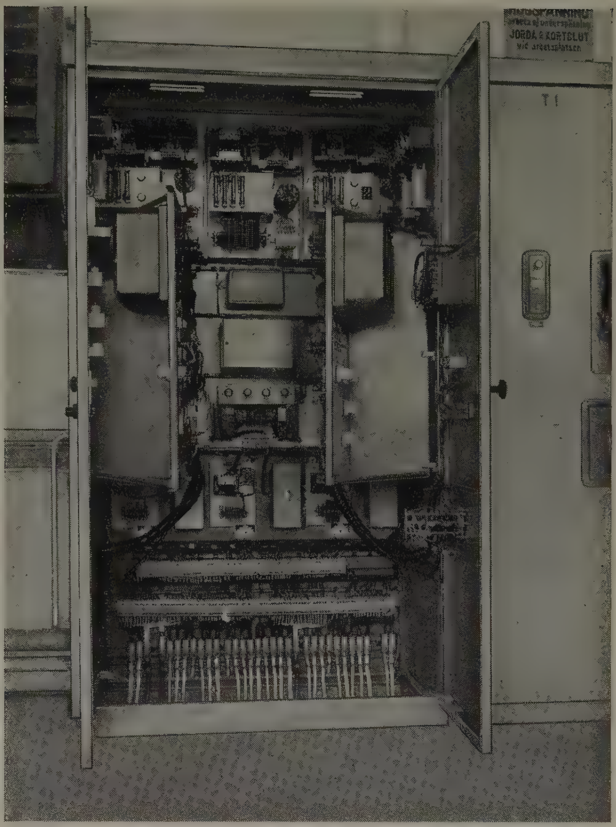


Fig. 8. Control cubicle with those components which are included in the regulating circuit after the error amplifier (see Fig. 1), relay stations for automatic operation, protective equipment and the signal station. (53344)

Running a programme cycle

In order to be able to start up the programme device, the low-voltage circuit-breakers must be closed. This, in its turn, means that everything is in the starting position as described above. The programme is started by pressing a button, whereupon a programme cycle is run through automatically. It is possible to stop the programme at any arbitrary point.

PROTECTIVE EQUIPMENT

The main electrical circuit in each system is protected by means of an instantaneous over-current relay and a thermal over-current relay, both tripping the circuit-breaker in the respective distribution cubicles.

It is, in principle, more difficult to protect the lamp load since use is made of more than twice the nominal voltage when running up the temperature. This voltage may not be switched on for a longer time than during the short running-up period, and therefore, the lamps are protected by means of a time-lag over-voltage relay.

The lamp voltage is limited to the running-up value quoted above by means of the voltage-limiting device 9.

LEVEL-LUFFING JIB CRANE FOR SÖDERHAMN HARBOUR

Carl-Henric Kochen, Crane Department, Västerås

Asea Reg. 63

In February 1959, a 6/7/10 ton level-luffing jib crane for handling piece goods and bulk cargoes, which was designed and manufactured by Asea, was inspected and handed over to the authorities at Söderhamn harbour. It made a welcome addition to the two older cranes already installed.

The crane is, to a very considerable extent, a copy of the one supplied to Härnösand harbour by Asea a couple of years ago, but it has a somewhat greater lifting capacity and is provided with unique portal travelling machinery. It has been so designed that the crane can move along the line of an S-shaped curve.

Technical data:

Lifting capacity, bulk cargoes including grab, Crane Group IV	6 tons
Lifting capacity, piece goods, Crane Group II	7 tons
Lifting capacity, piece goods, Crane Group I	10 tons
Maximum operating radius with loads of 6 and 7 tons	25 m
Maximum operating radius with loads of 10 tons	15 m
Minimum operating radius	8.5 m
Gauge of portal track on rail centres	9.66 m
Total height of lift	33 m
Lowest position of the hook below the upper edge of the crane-track rails	10 m
Lifting speed with load of 6 tons	60 m/min
Lifting speed with load of 7 tons	approx. 60 m/min
Lifting speed with load of 10 tons	approx. 30 m/min
Slewing speed	1.75 r/m
Horizontal speed of the hook when the jib is extended or withdrawn with a load of 6 tons	approx. 60 m/min
Speed of travel of the portal along a horizontal track with a load of 6 tons and a wind force of 15 kg/m²	18 m/min

MACHINERY

The crane is provided with grab machinery and lifting machinery, connected by means of a planetary gear. All the gears are oil lubricated and are enclosed in a common gearbox.

Some of the gears of the slewing machinery run in oil baths and some in oil mist. The slewing machinery, which forms one unit, is spring mounted.

The jib machinery, which is completely enclosed, consists, amongst other things, of a worm mechanism enclosed in a telescoping tube.

The portal is driven by two separate sets of machinery each located on its own bogie above the one rail. The bogies are specially designed so that they can turn an can move laterally in relation to the rail when runnin through curves.

STEELWORK

The portal, which is symmetrical, is of box-girder desig and therefore has smooth unbroken surfaces thus facilitating painting and other maintenance work.

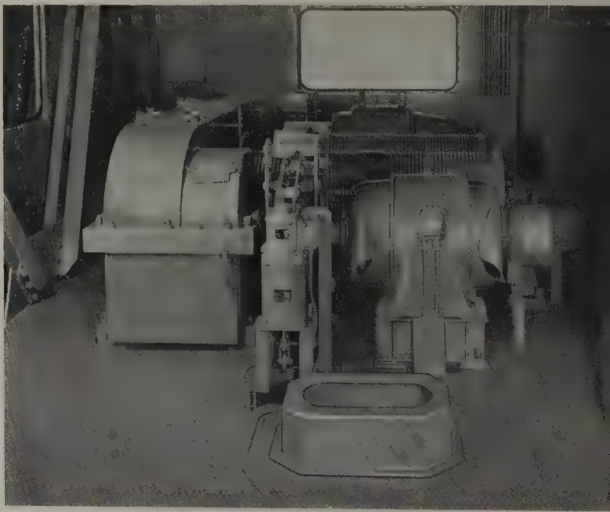
The crane house consists of the driver's cabin and machinery room and is completely enclosed in sheet stee and is insulated. Heaters are provided both in the driver' cabin and in the machinery room. The driver's cabin i well provided with windows thus ensuring an excellen view of operations.

The jib system, which consists of the luffing jib, th main jib, pull rods and counterweights, is of lattice desig

REGULATION

The crane has been provided with Leonard equipmen for the lifting and jib movements, while the drivin equipment for the traversing and portal travel movements consists of slip-ring induction motors. All the motors are regulated by means of operating-current controllers and contactors.

The lifting machinery and the grab machinery are linked b means of a planetary gear. (51702)



463)

ANECHOIC ROOM FOR MEASURING THE SOUND PRESSURE LEVEL OF TRANSFORMERS

Sigbjörn Haraldsen, High-voltage Laboratory, Ludvika

U.D.C. 534.62:621.314.21.01
Asea Reg. 0938

Brief account of the principles according to which a test room for acoustic measurements should be designed. Description of the anechoic room built at the Asea High-voltage Laboratory, Ludvika, for measuring the sound pressure level of transformers for ratings of up to 15 MVA. Results achieved.

The reduction of transformer noise has long constituted a problem facing the transformer designer and which has been accentuated during the last few years, both because the magnetic flux density of transformers has been increased and because it has been considered necessary to achieve low sound pressure levels in hospitals, blocks of flats and urban districts, where small transformers are often located.

For this reason, great efforts have been made at the Ludvika Works to develop more silent transformers. Since a test room for acoustic measurements was not available, the measurements had to be performed in the workshops or in the test rooms, which has been a far from ideal solution owing to the background noise and confined space. A high background noise is troublesome when making acoustic measurements on small distribution transformers, which in themselves are rather silent. It has thus long been a desire on the part of the Ludvika Works to obtain a test room for acoustic measurements, and this desire was realised in the spring of 1959, see Fig. 1.

DESIGN

When measuring the sound pressure level of transformers, there are, in principle, two types of test room available for acoustic measurements. One of these is a "hard" room with walls that reflect the entire sound. If the sound field in such a room is sufficiently diffused, it is possible to determine the radiated acoustic power by measuring the sound at an arbitrarily selected point. The measurements would consequently be very simple, but a disadvantage of such a room is that it is impossible to determine the location of the source of the sound emitted by the test object.

The other type of test room for acoustic measurements is the anechoic room, where hardly any sound at all is reflected from the walls, ceiling and floor. In this case, the sound must be measured at a number of points around the transformer, but it is then possible to determine easily the location of the different sources of sound. This is particularly advantageous when, for example, carrying out measurements on core and tran former models for the purpose of establishing wheth the design of any parts requires improving.

After the High-power Laboratory had moved into i new quarters at the Ludvika Works, a large test c which had been used for the testing of circuit-breake became available. The walls of this test cell were very robust concrete construction and thus were ideal suited as the skeleton for a test room for acoust measurements. At the same time, this test cell was sit ated in a part of the workshop subject to very litt background noise and small vibrations.

By modifying the test cell, it proved possible to obta a floor area of 85 m² (915 sq.ft) and a height of 7.9 (26 ft). The rebuilt walls consist of brick, and furthe more a concrete door, 4.9×6 m (16×19.5 ft), w added, through which transformers of up to 50 tons ca be transported on a truck with rubber wheels.

If an absolutely perfect anechoic room is desired, the surfaces must be covered with a sound-absorbi material. Furthermore, should the room be used f testing objects having a weight of up to 50 tons more, special, and expensive, arrangements must made to make the floor sound-absorbing. It was ther fore decided to build a conventional concrete floor, b in such a manner that, if it proved necessary later o a sound-absorbing layer could be added without ar essential modifications having to be made.

Mineral wool in the form of 60-cm-long (23.5 in wedges with the points facing inwards was used as t sound-absorbing material. The base of the wedges w placed on slabs of the same material with a thickne of 15 cm (6 in.). The dimensions have been select on the basis of the information given by Brandt a Hagman in an article published in the Teknisk Tidskri 80(1950):43, pp. 1087–1092.

The desired minimum frequency limit, that is to sa the frequency where the absorption coefficient of t material has dropped to 99 per cent, was fixed at 95 c which proved to be an economic limit and sufficient low for transformers, whose noise has a frequency 100 c/s or more.

The sound-absorbing material, with a density of kg/m³, was so loose that the wedges had to be he together by wire netting. In order to facilitate the ere tion, cubic cages were made with sufficient space f 18 wedges, having a base of 100×200 mm (4×8 in

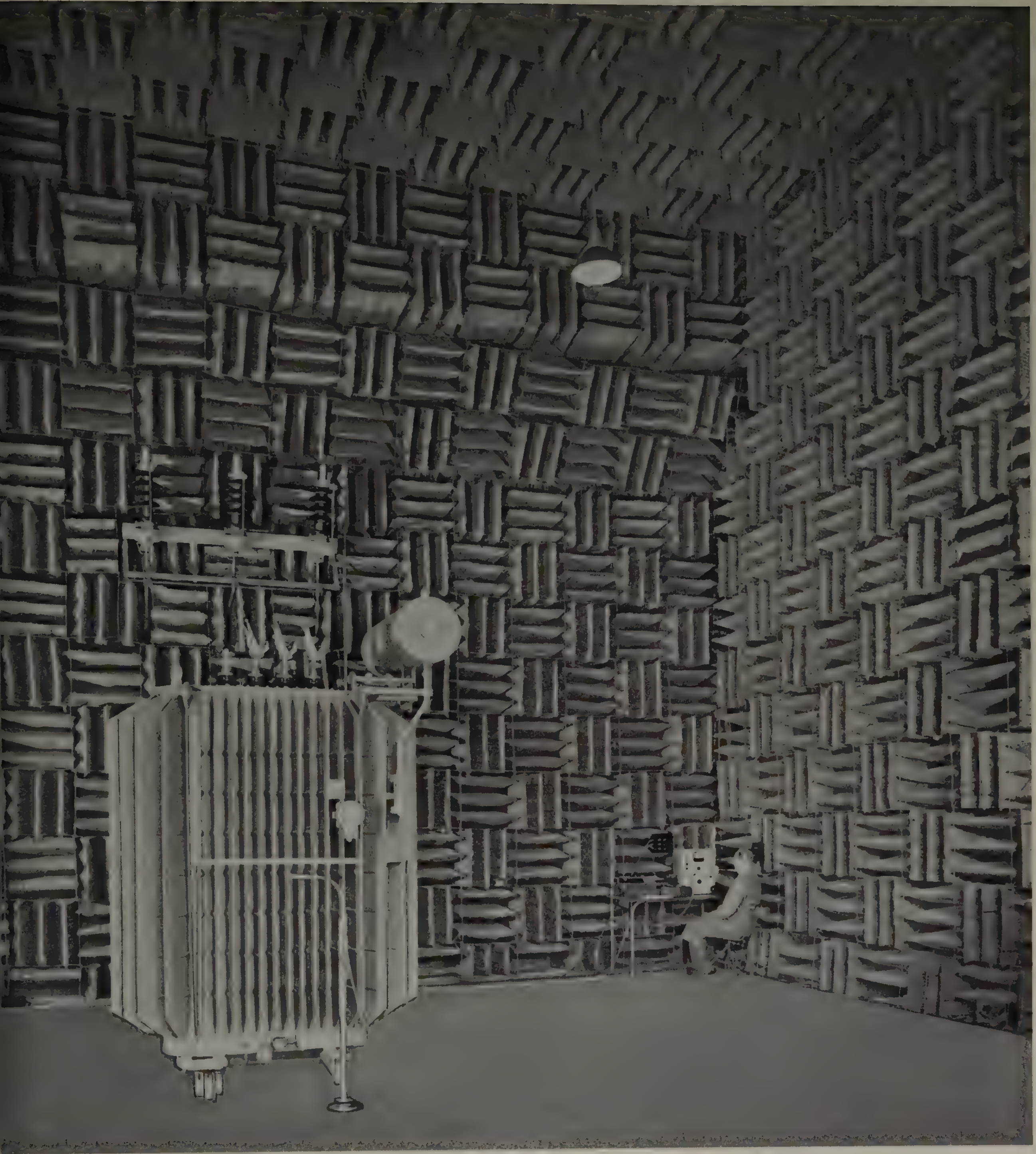


Fig. 1. Sound pressure level measurements on a 1,500 kVA transformer in the new anechoic room at the Ludvika Works. The room has a floor area of 85 m² (915 sq.ft) and a height of 7.9 m (26 ft). (54664)

The slabs, with a thickness of 7+8 cm (2.8+3.1 in.), were first attached to hooks of reinforcing steel, which had been grouted or driven into the walls and ceiling. A mesh of reinforcing steel was then suspended outside these slabs from the walls and the ceiling. After this, the cages containing the wedges were secured on the mesh of reinforcing steel by means of wire (see Fig. 2).

MEASUREMENTS

The background noise in the finished anechoic room was found to be about 25 dB (weighted curve A). This sound pressure level is sufficiently low to enable measurements to be performed even on the most silent small distribution transformers. In order to judge the sound-absorbing capacity of the walls, an almost punctiform source of sound was placed in the middle of the anechoic room, and the sound pressure level was measured at different distances from the sound source. When the conditions are ideal, the sound pressure level drops 6 dB

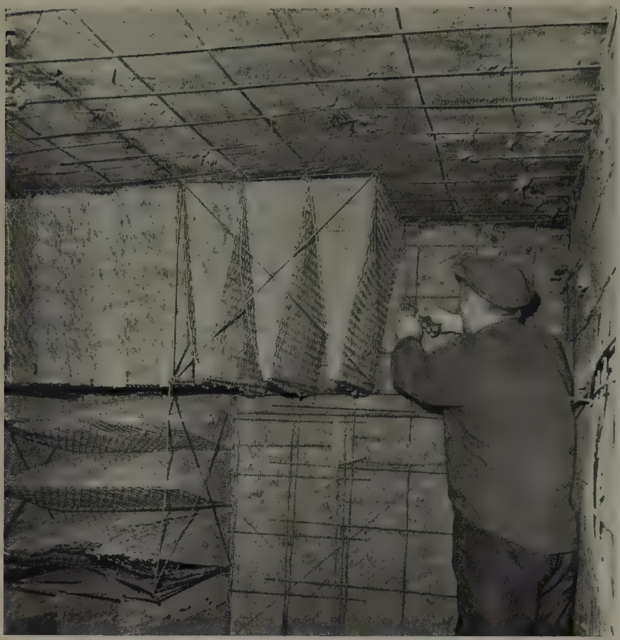
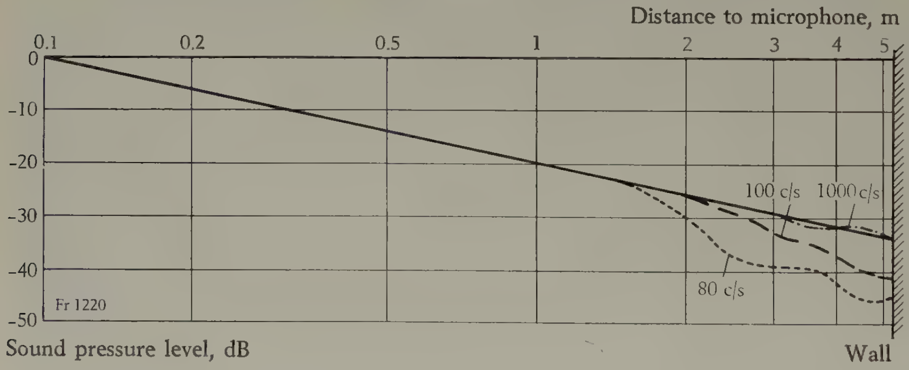


Fig. 2. Erection of the sound-absorbing material. The wedges of mineral wool are placed in cages of steel rod and wire netting and are suspended in a mesh of reinforcing steel. (Z 11295)

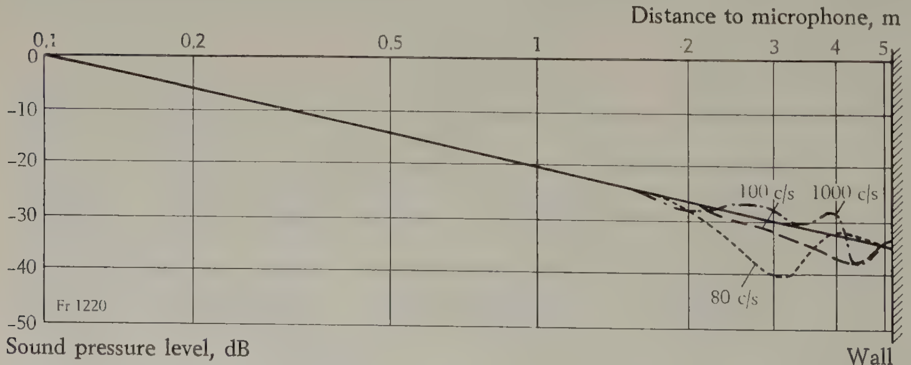
for each doubling of the distance. This ideal curve I been plotted in Fig. 3 together with curves for measu ments at 80, 100 and 1,000 c/s. The curves in Fig. : have been measured with a sound-reflecting concr floor in the anechoic room, whereas the curves sho in Fig. 3 a are plotted on the basis of measureme made when wedges similar to those used in the ceili and walls were placed on the floor.

At high frequencies (1,000 c/s) the sound-absorbi floor is considerably better than a hard floor, where at 100 c/s the situation is almost the reverse. With hard floor it is apparent that the deviations for 100 and 1,000 c/s from the ideal curve are less than 2 up to a distance of 3.5 m (11.5 ft) from a punctifo sound source.

With the present transport facilities available, it possible to accommodate in the anechoic room tra formers of sizes up to about 15 MVA (or a weight 50 t). Up to now, the greater part of the measureme have been made on transformers of the order 30–1,500 kVA, both oil-insulated and dry types. Fu thermore, vibration and sound pressure level measu ments have been performed on cores of different siz and on transformer models.

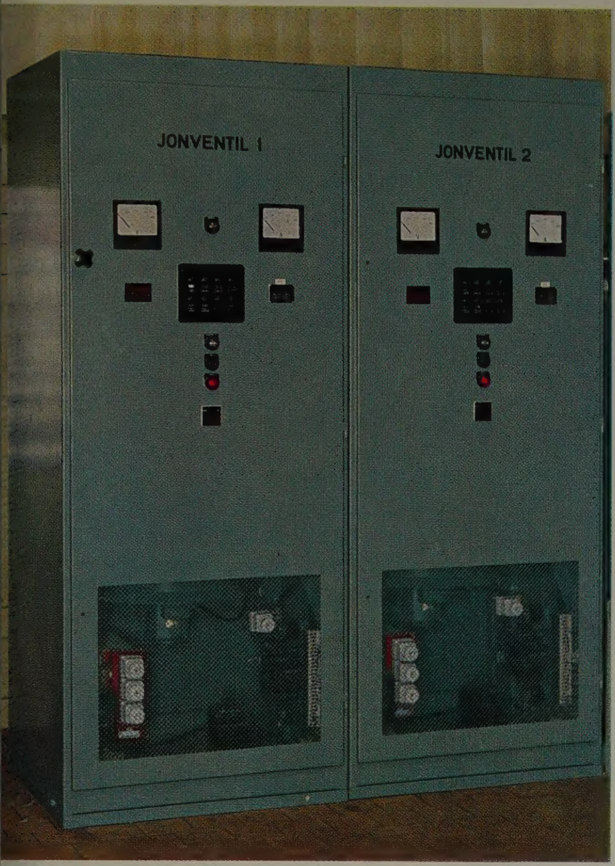


a) With wedges on the floor

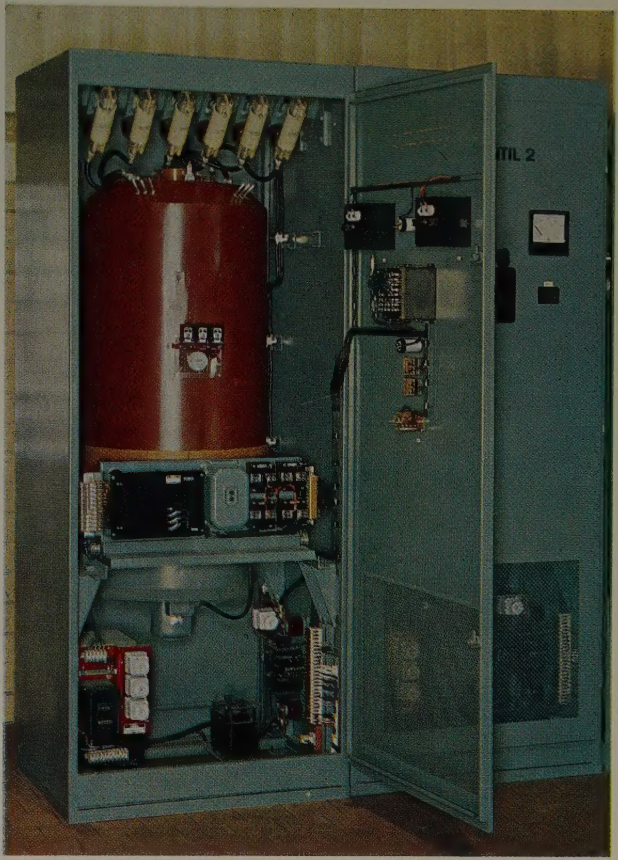


b) Without wedges on the floor

Fig. 3. Measurements of t absorption capacity of t walls. At 100 % absorpti the sound pressure le drops by 6 dB for ea doubling of the distan (the ideal curve).



(F 570)



(F 571)

EWS IN BRIEF

ERCURY-ARC RECTIFIER TYPE SAK 5

he most recent design of mercury-arc ectifier developed by Asea has been iven the type designation JSAK 5. It as anode bushings at the top, thermotats and thermometer in the middle of he tank, and an insulated cathode at he bottom. The rectifier and its assoiated fan and control panel are mounted n a truck.

he mercury-arc rectifier is housed in cubicle 900 mm (35 in.) wide, 900 nm (35 in.) deep and 2,250 mm (89 n.) high, that is to say, the same dinensions as for standard switchgear cuicles. The upper part of the cubicle acommodates the anode fuses. Below these, there is the rectifier with its control panel, which contains the grid-voltage device, the motor starter for the fan and the isolating transformers for the thermostats. Finally, the space below the rectifier houses the cooling fan, the excitation equipment, the current-measuring transductor, a thermal relay, etc. The cubicle door incorporates instruments, signal station, pushbuttons for starting and stopping, as well as indicating lamps. The mercury-arc rectifier is of pumpless design.

The first mercury-arc rectifier of this type was manufactured for the Asea High-current Laboratory at Ludvika, and it is employed for the excitation of the 60 MVA short-circuit test generator [see the Asea Journal 33(1960):10–11, pp. 155–161]. This rectifier is rated at 300 or 500 V, 300 A, d.c., continuous output, or 1,200 A, for 2 seconds.

The illustrations above show a set of rectifiers forming part of the model of a rolling mill which is used in the static-converter test room at Ludvika.

These mercury-arc rectifiers are also used for the individual supplying of the drive motors in rod rolling mills, the auxiliary motors in reversing blooming and plate rolling mills, as well as for the and plate rolling mills, as well as for the excitation of large d.c. machines, etc.

In every case the mercury-arc rectifiers are grid-controlled and they can operate both as rectifier and inverter.

Asea Reg. 4899

ASEA COMMUTATOR DRIVE EQUI MENT FOR PHOTOGRAVURE AN NEWSPAPER PRESSES

For many years Asea have been active engaged in the designing and manufa ture of electrical drive equipment f printing presses. This equipment is ve often centred around the three-pha commutator motor, which has well pro ed its ability to meet the exacting r quirements regarding speed regulatio etc., in the printing trade. Both grou drive and unit drive can be based c the commutator motor, and Asea driv and control equipment of these types to be found in numerous printing worl and newspaper offices all over the worl

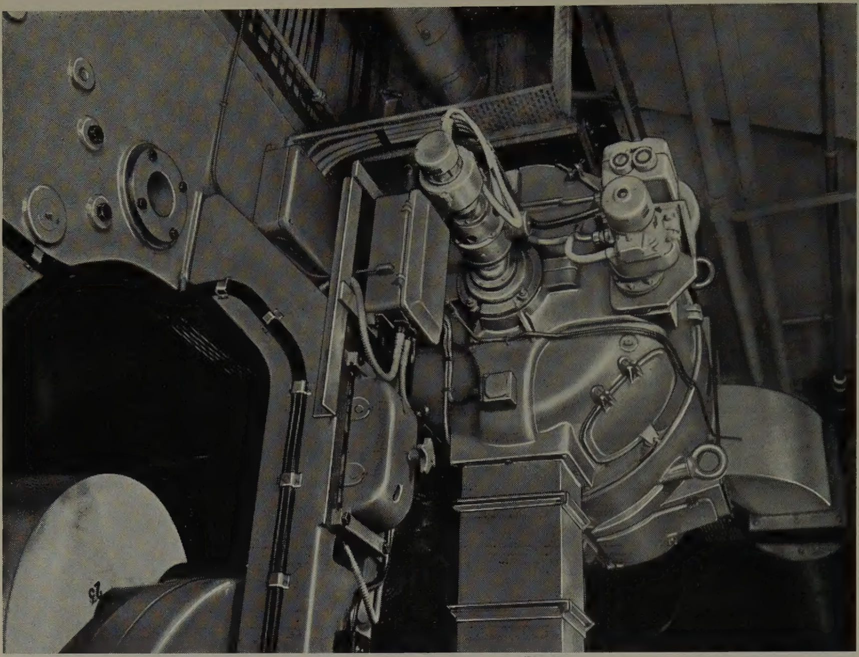


Fig. 1. One of the 85 h.p. commutat motors supplied by Asea to Messr Samuel Stephens, London, mounted c the substructure of a Frankenthal phot gravure press. (55943)

One of the more recent deliveries is th drive and control equipment supplie through Fuller Electric Ltd., Londo to Messrs. Samuel Stephens of Londo This company has installed a ne Frankenthal photogravure press consis ing of eight units and two folders, gea ed for a maximum speed of 15,000 cy linder revolutions per hour. Two Ase forced-ventilated three-phase commut tor motors of type KB 84, rated at 8.5–8 h.p., 105–1,050 r/m, are used for dri ing the press. The motors can be regula ed down, however, to 25 r/m for incl ing purposes when starting up th press. One of the motors can be see in Fig. 1 mounted on the press su structure.

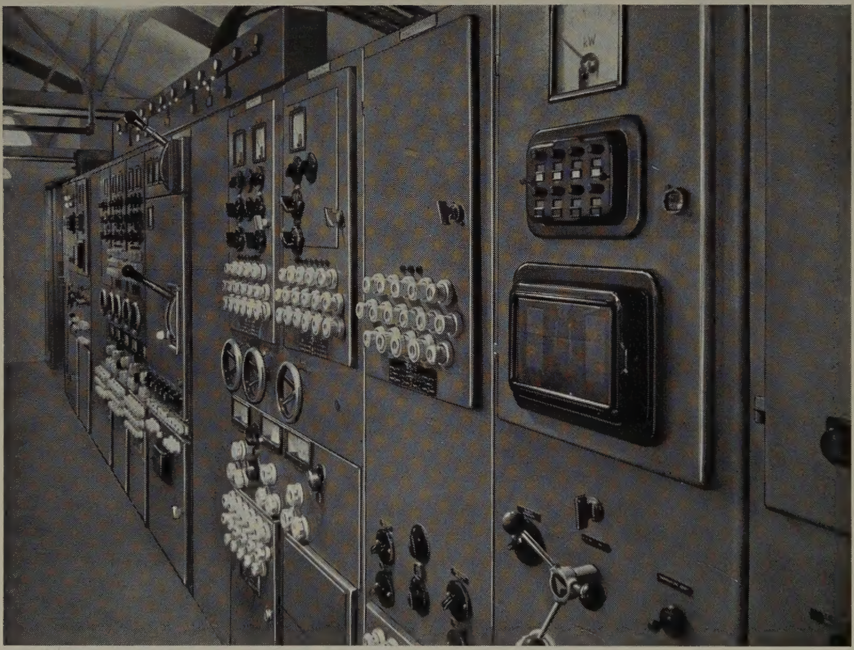


Fig. 2. Control-gear cubicle for the ele trical equipment for a photogravu press. (55941)

Asea have also supplied the auxilia machinery for the press as well as th control gear. The main control-gear c bicles are shown in Fig. 2. The enti equipment is of flameproof design a conforms with the requirements in Cer ficate No. IS 2011 issued by the Minist of Fuel and Power. The photographs a reproduced with the kind permission Messrs. Samuel Stephens.

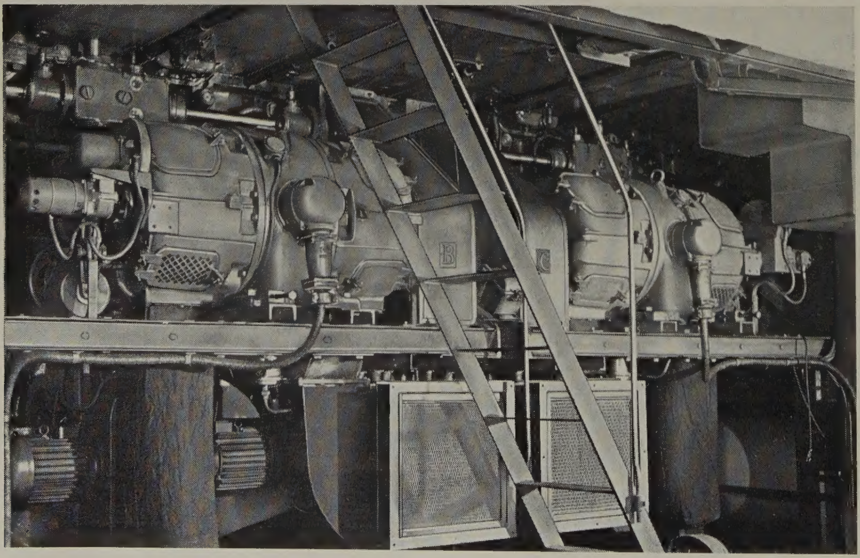


Fig. 3. Two Asea 45 h.p. commutat motors forming part of the unit dri for a Marinoni newspaper press at t offices of the French newspaper Su Ouest. (56747)

s a typical example of the unit drive or newspaper presses may be mentioned e equipment supplied by Asea through Iessrs. AHIL, Paris, to the offices of ud-Ouest, formerly La Petite Gironde, ordeaux, who publish one of the leadng provincial newspapers in France. 'his press, of Marinoni design, consisted n its initial stage of eight printing units nd four folders. Recently a further unit as been added.

sea have supplied for the unit drive of e press nine three-phase commutator otors of type KB 53, with a maximum ating of 45 h.p. at 1,750 r/m, which an be regulated down to a speed of 4 r/m for inching. Two of these achines are shown in Fig. 3 at the ide of the press. Asea have also supplied the entire control-gear equipment, nd the main control-gear cubicles are hown in Fig. 4. Asea Reg. 858

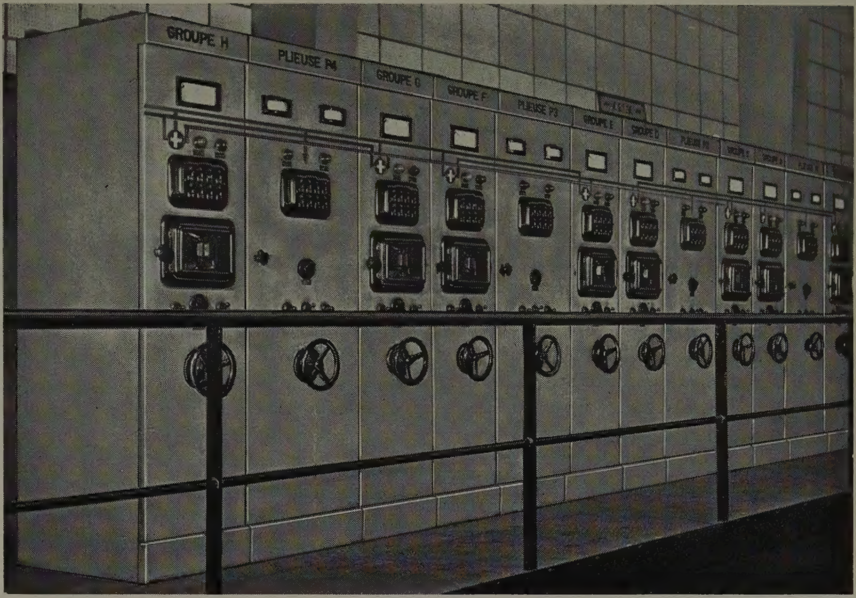
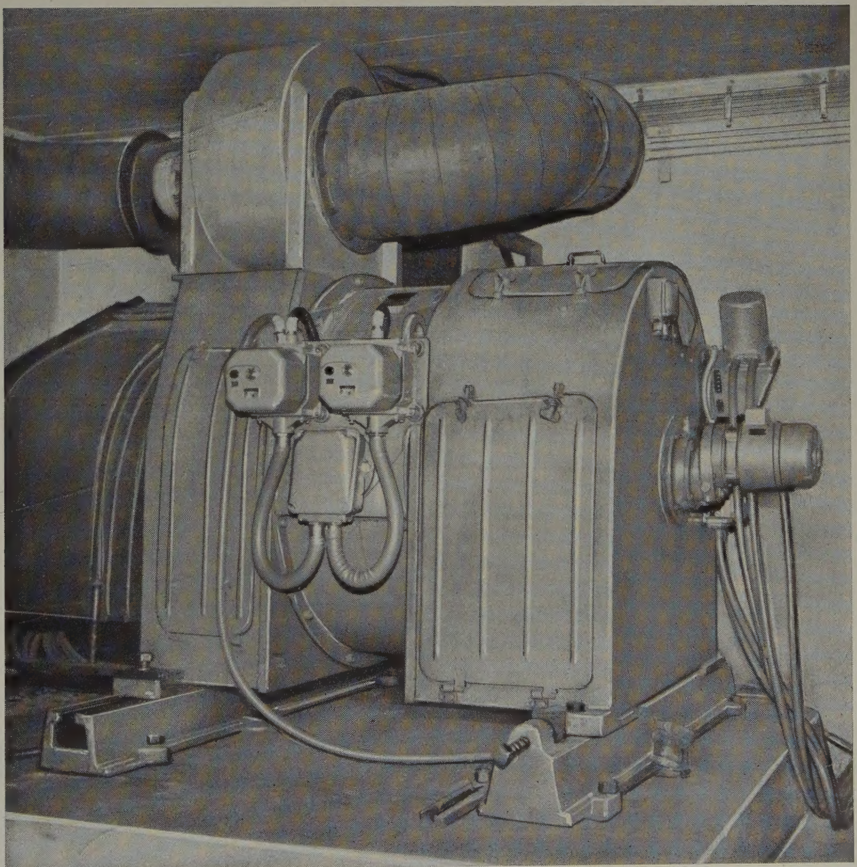


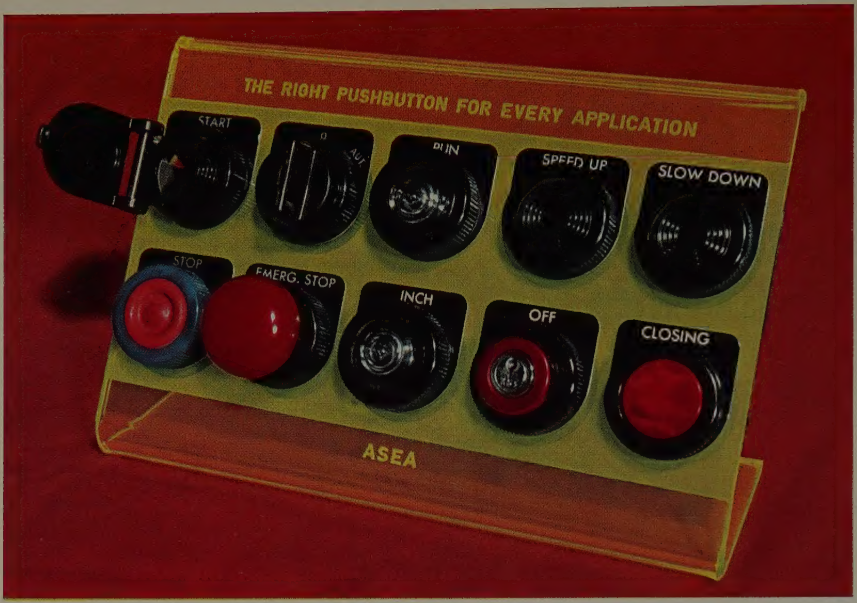
Fig. 4. Control-gear cubicles for the newspaper press illustrated in Fig. 3. (56746)

COMMUTATOR MOTOR STANDING ON ITS BEARING END-SHIELDS

A design of Asea commutator motor (type KB) which stands on its bearing nd-shields is now available. This enures more stable running when using V-belt drive. The illustration shows a 5–150 h.p., 83–830 r/m, 500 V, 50 c/s otor set up in the premises of the ustomer, Katrinefors AB, Sweden. The otor is used for driving a paper mastrated in Fig. 4. Asea Reg. 4452



(54347)



(F 674)

MODERN PUSHBUTTONS

The pushbutton represents the simplest means of communicating an order and initiating a previously determined operating sequence, and it is therefore to be found in, practically speaking, all kinds of electrical equipment. For this reason, it should be reliable in service and readily adaptable for various conditions. At the same time, it should also have an attractive appearance. The new Asea pushbuttons are of robust design both electrically and mechanically. They are primarily intended to be built into instrument panels, but are also available in enclosed designs for normal and marine use. They are built up of 15 standard components which allow of no less than 56 combinations. The illustration shows some of these set up for demonstration purposes (the pushbutton at the extreme left of the upper row has been cut open in order to show the membrane seal). The pushbuttons have previously been described in Asea Journal 31(1958):10, pp. 139–142. Asea Reg. 5372

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ASEA JOURNA

1961 VOLUME 34

CONTENTS

Capacitor bank with harmonic filters
by H. Stackegård

A heating installation with 750 kW transductors
by N. E. Ström

Level-luffing jib crane for Söderhamn harbour
by C.-H. Kochen

Anechoic room for measuring the sound pressure level of transformers
by S. Haraldsen

News in brief

Mercury-arc rectifier type JSAK 5

Asea commutator drive equipment for photogravure and newspaper presses

Commutator motor standing on its bearing end-shields

Modern pushbuttons

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